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# trigonometry comes alive through DIGITAL STORYTELLING

*High school students create digital story problems about real-life situations and then apply trigonometric functions to solve these problems.*

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Story problems are a part of most mathematics curricula and are sometimes used as writing exercises in mathematics classrooms. Such writing exercises may include requiring students to rewrite story problems in their own words, using language that is familiar to them, or rewriting story problems using simpler number facts (Stein 1998). The current emphasis on rigor and relevance in classrooms places even more significance on connecting such problems to real-life situations and solutions in relationship to mathematical thinking.

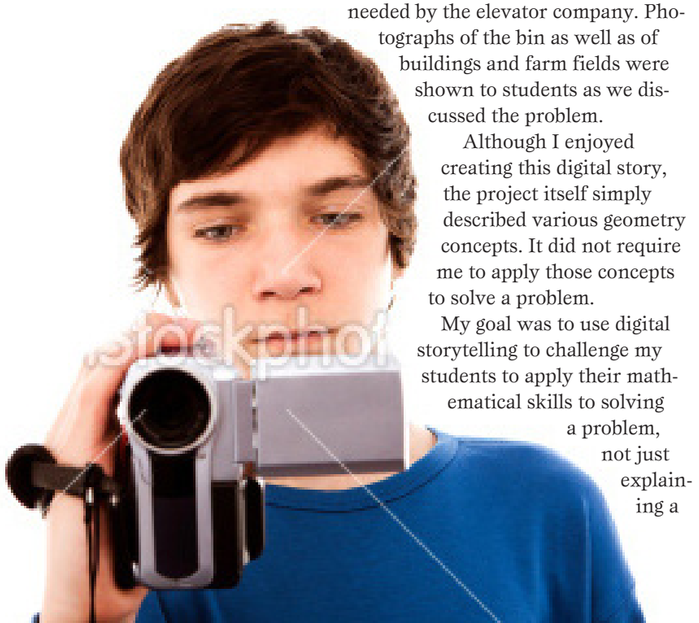
In the textbook that I have used for the past several years, story problems typically appear at the end of the instructional units, usually in sections entitled "Problem Solving." (Throughout this article, the narrator is Gould.) For my students, as a result, "problem solving" meant solving textbook story problems. When it was time to work these problems, I would jokingly refer to them as "everyone's favorite type of problem," a comment usually followed by groans.

## MY INTRODUCTION TO DIGITAL STORYTELLING

Several years ago, I was taking a graduate class at a nearby university that focused on teaching and learning with technology. This course introduced me to the concept of digital storytelling—combining images and sound to tell a story (Baggett 2007)—and I began to examine how I might use it in my classroom (Lambert 2006). I immediately recognized the power of this magical combination, but I wondered how digital storytelling would fit into my high school mathematics classroom. Most of the digital stories presented in this course were related to personal, often emotional, experiences. Mathematics brought out certain emotions in some of my students, but I knew that these particular emotions and attitudes would probably not make good digital stories!

Over the next several years, I took advantage of several other professional development opportunities related to digital storytelling. I learned a great deal about the process involved in writing a good story and then how to use images and sound to tell the story in engaging and powerful ways (Ohler 2008). This process, I discovered, is relational; its effectiveness comes from interacting with peers in a recursive editing process and then using peers' suggestions to clarify and improve the digital story.

I developed a digital story that illustrated how geometric concepts are found in real-life situations for a graduate course I was taking (Sharp, Garofalo, and Thompson 2004). The subject was a new storage bin that had been recently constructed at the grain elevator near my hometown. The story described how the engineers who designed the bin used the formula for volume of a cylinder ($V = r^2h$) and for volume of a cone ($V = r^2h/3$) to determine possible dimensions of the bin given the volume needed by the elevator company. Photographs of the bin as well as of buildings and farm fields were shown to students as we discussed the problem.



Although I enjoyed creating this digital story, the project itself simply described various geometry concepts. It did not require me to apply those concepts to solve a problem.

My goal was to use digital storytelling to challenge my students to apply their mathematical skills to solving a problem, not just explaining a mathematical concept (NCTM 2000; Peressini and Knuth 2005). Ideally, digital storytelling would be a mechanism for my students to use problem-solving skills while finding solutions to real-life problems. According to Stein's research (1998), students tended to think that most textbook story problems were not relevant to their lives, and Winograd (1990) reported that students felt more challenged by story problems written by their peers. After struggling to generate ideas for using digital storytelling in my classroom, I finally explored the possibility of having students create and solve digital trigonometry story problems.

I consider myself a rather traditional mathematics teacher. A typical class includes discussing students' questions about assignments, checking assignments, reviewing answers, presenting notes on a new concept (including working through some examples), and giving another assignment. In twenty-one years of teaching, I had never asked my mathematics students to complete a technology project. For me, it was a real stretch for me to make time in the curriculum to have students develop an original story problem and produce it using iMovie™.

In the past, my students had created story problems after studying trigonometry concepts and solving story problems from the textbook. Students were required to write a story problem that used sine, cosine, or tangent to find a distance or an angle, and then they drew a picture to illustrate the problem. Their problems ranged from a rewrite of a textbook problem to a problem involving calculating the height of a monster attacking our town. My journey into digital storytelling began as I considered how these trigonometry story problems, previously handwritten and illustrated on an 8 1/2-by-11-inch sheet of paper, could come to life as digital stories.

## GETTING STARTED

This digital storytelling project involved students enrolled in my three geometry classes, the majority of whom were freshmen and sophomores. The students produced digital trigonometry story problems by situating their problems within real-life scenarios. Students were required to include video or still pictures and a recorded narration that told the problem's story. This project was the culminating activity in the trigonometry unit for my geometry classes.

One challenge in implementing this project was adequate student access to the technology (Alejandre 2005). Students' main access to technology was the school's computer lab, which has twenty-five computers that can be reserved for student use. (Some students used their own digital cameras or cell phones to take the photographs they needed to tell their story.) Students spent six full class periods in the computer lab putting together their digital story problems. They also used the lab outside class time, during study halls, and before and after school.

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A further challenge was that students did not have a separate work area for recording their story problems. As a result, they had to record their narrations in the computer lab while their classmates listened and worked on their own projects. Although the logistical arrangement for assembling the digital stories was not ideal, we made it work.

## PLANNING AND CREATING THE DIGITAL STORIES

Several days before the digital storytelling project began, I gave my students a project overview and shared the grading criteria. Students were asked to work in pairs or triads. They brainstormed for ideas for the story problems and recorded their ideas in a writing journal. I also encouraged them to review trigonometry story problems in the textbook. Group members continued to refine and revise their ideas over the next few days.

After each group had selected its topic, the next three days were devoted to writing the digital stories. Each team revised its story within the group, shared the story with other groups, and then decided what photographs to take to tell the story. Students were required to take and submit photographs showing the context of the problem, a requirement that further emphasized the real-life connection. One group used the high school football field, one group photographed a downtown bank, and still another group met at a neighborhood playground. At these locations, students recorded the measurements needed for solving their problems, using tape measures to measure distances and clinometers to measure angles.

Following this preparation, each group met in the computer lab for another three class periods to use iMovie to create its digital story problem. Most students had taken a computer class that taught them how to use the application, so I provided little training. I relied heavily on students to help one another with technology problems, an approach that could be frustrating at times. A few groups lost their projects to computer crashes, but most regrouped and reproduced their work.

## SHARING THE STORY: ONE EXAMPLE

Students created a variety of problems, ranging from adventures to personal challenges. One story, created by three male students, constituted a mathematical as well as a physical challenge. Two students in this group were members of the high school swim team, a natural context for a problem. The story began with the two swim team members arguing about who got a better start off the blocks during a race and evolved into an attempt to prove who really did.

Using the computer's built-in camera, the group recorded the opening scene, in which the two swimmers argue over who gets off to a better start. The third group member suggests that they use trigonometry to determine this by measuring the angle at which each enters the water. Next, we see the two swimmers preparing to dive into the high school pool. In a fashion similar to a prizefight, the challengers are introduced, and the "fight" is on.

This group used still images to illustrate the angle at which each student entered the water. The students added lines and measurements to the photograph, and these provided useful information for solving the problem (see **fig. 1**). The problem ended with a *Wide World of Sports* moment—images and narration showing the thrill of victory and the agony of defeat.

As the conclusion to its digital story, each group was required to include a solution. The students in the swim team group included three slides that documented how they solved their problem (see **fig. 2**).

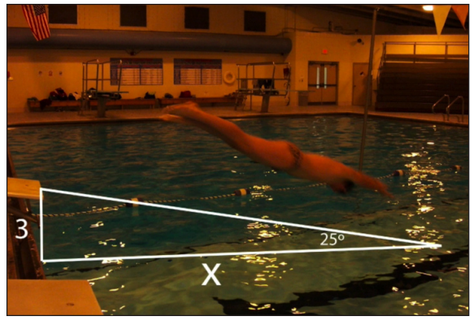


**Fig. 1** Photographs such as this illustrated the angle at which the swimmers entered the water.

| | | |
|---|---|---|
| Distance Chad jumped is Tangent $28° = \frac{3}{x}$ | Distance Chad jumped is $.5317 = \frac{3}{x}$ | $x = \frac{3}{.5317}$ |
| | | Distance Chad jumped is 5.6 feet |
| Distance Joe jumped is Tangent $25° = \frac{3}{x}$ | Distance Joe jumped is $.4663 = \frac{3}{x}$ | $x = \frac{3}{.4663}$ |
| | | Distance Joe jumped is 6.4 feet |
| **Slide 1: Trigonometric equation** | **Slide 2: Values for trigonometric equation** | **Slide 3: Problem solution** |

**Fig. 2** Student work for the swim team problem included equations and their solutions.

The first slide showed the trigonometric equation, the second slide included the values substituted in the trigonometric function, and the third slide revealed the problem's solution. During the groups' presentation of the digital stories, we paused each story before the solution was shown, so that students watching the stories could solve the problems.

The three students who created this trigonometry story problem were highly engaged in creating the project because it was based on an important aspect of their lives. First, they used their experiences as swimmers. Second, they presented the story in a humorous manner consistent with their personalities. Their humor captured viewers' interest but did not distract from the plot (or purpose). This digital story was one of the more interesting stories to watch and solve because the students' recorded interactions were quite entertaining.

Other students produced very thought-provoking and engaging digital stories. These problems varied from finding the length of a zip line needed to foil a bank robbery to determining the length of a guy wire needed to brace a telephone pole. One group even visited a neighborhood park to set up a problem for calculating the length for an additional brace needed on a slide.

## EXAMINING THE RESULTS

Before the unit began, students took a pretest consisting of three written trigonometry story problems. After completing their digital storytelling projects, students took a posttest that included three digital story problems created by students in another geometry class. The mean difference between students' scores on the pretest (59.8) and their scores on the posttest (73.1) indicated a significant difference ($p = .05$) between pretest and posttest means in their ability to solve trigonometry story problems ($t = 2.528$, $p = .012$). For a majority of students, their score from pretest to posttest reflected a double-digit increase. These results indicated that creating and using digital trigonometry story problems, at least with this particular group of students, seemed to help them solve these types of problems.

At the end of the unit, three students from each geometry class participated in a focus group interview. During these interviews, students discussed the challenges and benefits of completing such a project in a mathematics class. The main challenges, they reported, were coming up with a trigonometry problem that could be illustrated with photographs, finding time to work with their partners outside class, and putting the digital story together. As for the project's benefits, the students stated that they liked working with partners; they did not have to do everything themselves, and it was easier to come up with a creative idea by talking together. Students seemed to gain a great deal from working collaboratively, not always a typical result in mathematics classrooms. In addition, students felt that this project allowed them to do something they were good at—technology. Some students also stated that they understood trigonometry story problems better when the problems were presented in a visual format.

From a teacher's standpoint, it was quite interesting to observe students throughout the process because they were excited about creating their digital story problems and motivated to do so (Peressini and Knuth 2005). Almost all students were deeply engaged in their projects. The students' motivation level throughout the project was significantly higher than what I typically observed when students solved story problems from a textbook. The combination of the students' motivation and this nontraditional approach provided students with the best opportunity for success when applying trigonometry to their lives and the world around them.

## CONCLUSION

This digital storytelling project provided my students with a learning opportunity that connected mathematical concepts to their real-world experiences. The real-life settings and the stories told captured students' attention and held it. One of the more important benefits that resulted from this project was that students answered the question, "When are we ever going to use this?" by solving problems from their daily lives.

At the beginning of this project, I was apprehensive, but now I eagerly await next year, when I plan to carry out this project again. Although this project was challenging for me personally, the greatest thing I gained from this experience was the realization that students need projects like this to express their creativity—even in a mathematics classroom. I discovered students' talents that helped me see my students as more than just mathematics students. Further, it was good to let go of the traditional curriculum of mathematical problem solving so that students could take responsibility for their own learning.

One student put it this way: "I'm not sure how I will ever feel about story problems, but I'm sure I'll remember this project."

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